ENGINEERING DESIGN FILE
CPP-603 Radionuclide Sample Results

EDF No.: 4235 EDF Rev. No.: 1 Project File No.:

1. Title: CPP-603 Radionuclide Sample Results Page 1 of 16

2. Index Codes:
Building/Type CPP-603 SSC ID N/A Site Area INTEC

3. NPH Performance Category: ________ or ☒ N/A

4. EDF Safety Category: ________ or ☒ N/A SCC Safety Category: ________ or ☒ N/A

Summary: Samples of the sludge on the floor and water of the CPP-603 basins were taken for analysis of the uranium and radiological constituents. Twenty-one samples of sludge were taken from randomly assigned locations in the pools and analyzed for alpha, beta and gamma emitters as well as uranium, americium and plutonium. Analysis for H-3, C-14, Tc-99, and I-129 was performed on four water samples taken independently of the sludge samples. Measurements were made of sludge depth at various locations in the pools, from which an aggregate sludge volume was estimated. No analysis for hazardous constituents was performed as these analyses were previously conducted.

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13. Registered Professional Engineer's Stamp (if required)		

1. Purpose

Report on results of CPP-603 radionuclide samples.

2. Summary

Twenty-one samples of the sludge on the floor of the CPP-603 basins were taken for the purpose of determining the uranium and radiological source term in support of facility closure. Twenty-one samples were taken from 15 randomly assigned and 3 specified locations in the pools. Duplicate samples were taken at three of the 15 random locations. Analysis for alpha, beta and gamma emitters as well as uranium, americium and plutonium was performed. Measurements were made of sludge depth at various locations in the pools, from which an aggregate sludge volume was estimated. Analysis for H-3, C-14, Tc-99, and I-129 was performed on water samples taken independently of the sludge samples. These analyses are presented in Appendix B. No analysis for hazardous constituents was performed as these analyses were previously conducted. (Demmer, 1996)

3. Background

The CPP-603 spent nuclear fuel storage basins are being prepared for deactivation. The stored fuel has been removed and the floor surfaces have been scanned using gamma ray spectrometry to derive an estimate of the fissile material in the particulate phase of the floor debris (EDF-3535). Several types of radiological constituents in the basin are assumed to be present in the basin. The first is small, discrete pieces that are detectable by floor scanning. The second is the small, readily-suspended particulate composed of corrosion product, wind blown dust, and precipitated or adsorbed radiological material that makes up the largest mass of the material on the floor. The third is high activity objects that were discovered by scanning. The dissolved species in the basin water are another contributor to the radionuclide inventory. The sludge sampling effort was intended to characterize the readily suspended particulate. The sludge has been sampled on previous occasions with a radiological constraint of 100 mR/hr maximum sample activity. (Demmer, 1996) Four composite samples were analyzed. No analysis for bulk density or particle size distribution was performed. To develop a more current and representative profile, samples of CPP-603 sludge were taken in October, November and December of 2002. Liquid samples were taken in June 2003.

The sludge in the CPP-603 basins is expected to have some variability, since different fuels were stored in each basin with limited mixing. Sludge was vacuumed from the North and Middle Basins in 1978 and 1987. The South Basin area between racks was vacuumed in 1978.

4. Sampling

4.1 Sample Acquisition

Twenty-one samples were taken, representing 15 randomly selected locations in all three basins, two cask unloading pits, the transfer canal and one unloading pool. Duplicate samples were taken at three locations. Three samples were taken in high activity areas as indicated by basin floor scans. Particles greater than 0.125" diameter were excluded to minimize radiological exposure if brought to the surface during sampling. The samples were controlled to a radiological upper limit of 3 R/hr, based on shielding limits of the transfer container for moving the samples to the lab. (The shielded container that mates to the receiving port for the Remote Analytical Laboratory is limited to 3 R/hr.) The inlet of the sample tube was screened to prevent particles larger than 0.125" diameter from passing to avoid uptake of high activity pieces. The samples were taken using a peristaltic pump located at the personnel operating level. During sampling, the highest activity sample bottle was 30 mR/hr.

To produce a localized representative sample, a controlled volume of the sludge on the basin floor was mixed. The sample was extracted from that volume while the sludge was suspended. The controlled volume was a right circular cylinder 8" ID by 12" high. This size was selected to meet the physical constraints in the facility and the area viewed by the gamma ray spectrometry scanning of the floor. The intent was to mix the sludge and remove the sample without displacing any high activity objects identified during scanning. Samples were taken from the locations shown in Appendix C3.

Samples were taken according to PLN-977 Field Sampling Plan for the CPP-603 Basin Sludge, using INTEC-TPR-P3.2-X6 Operate Sample Isolation Device. Due to resource availability constraints, sampling took place in October, November and December, 2002. Duplicate samples noted as samples 3, 6, and 14 were taken at positions noted as 2, 5, and 13 in the North, and Middle Basins and in the Transfer Channel. Samples were taken in high activity locations at positions in the Middle and South Basins. Table 3 of PLN-977, given in Appendix C1, provides location coordinates that correspond to the locations shown on Appendix C2. A map of sample locations is shown in Appendix C3.

4.2 Sample Analysis

The analyses performed on the samples were as specified in PLN-977 Table 4, attached as Appendix D. The INTEC Analytical Laboratory sample log numbers for the sludge were 02010141, 0201183, and 0301063. Log number 0305223 is the water sample for supplemental isotopic analysis.

5. Analysis:

5.1 Sludge Volume Estimate

The mean observed sludge depth was measured by inserting a steel rule into the sludge and observing the reading using an underwater video camera. Six locations were measured in each of the North and Middle Basins and 10 locations were measured in the South Basin and South Unloading Pool. Six locations were measured in the Transfer Canal.

South Basin	Depth (in.)		**Middle Basin**	Depth (in.)		**North Basin**	Depth (in.)	
N-S Basin Crossover	2.5		R33 PO	0.5		R2 PQ	2	
20' E 25' N	2		R33 PI	1		R2 PI	1	
20' E 30' N	7.5		R41 PN	0.5		R15 PP	0.5	
50'E 20' N	1		R41 PG	0.5		R15 PF	0.5	
60'E 30'N	3		R41 PG	0.5		R25 PP	0.5	
60'E 15'N	3		R53 PN	1.5		R25 RE	2	
			R53 PC	0.5				
			*R is row (E-W), P is position (N-S)					
S Basin Average Depth	3.17	in	M Basin Avg Depth	0.714	in	N Basin Avg Depth	1.08	in
S Basin Width	44	ft	Middle Basin Width	40	ft	N Basin Width	40	ft
S Basin Length	78	ft	Middle Basin Length	60	ft	N Basin Length	60	ft
S Basin Floor Area	3432	ft2	Middle Floor Area	2400	ft2	N Basin Floor Area	2400	ft2
S Basin Sludge Volume	906	ft3	M Basin Sludge Volume	143	ft3	N Basin Vol ft3	217	ft3
South Unl. Pool			**Transfer Canal**	Depth (in.)		**Unl. Pits**	Depth (in.)	
SW Corner Unl Pool	2		SE End	1.5		Interface	0.5	
NE Corner Unl Pool	2		By Interface	1		North Pit	1	
Unl Pool-S Basin Crossover	1		W Spur by Interface	1		South Pit	0.5	
SE Corner Unl Pool	3		15' S of Xfr Xover	1				
			E Spur by Crossover	1				
			Spur to Unl. Pits	0.5				
S Unl Pool Average Depth	2	in	Xfr Canal Average Depth	1	in	Pit Average Depth	0.667	in
Unl Pool Width	20	ft	Xfr Canal Width	7	ft	Unl Pit Width	7	ft
Unl Pool Length	22	ft	Xfr Canal Length	200	ft	Unl Pit Length	30	ft
Unl Pool Floor Area	440	ft2	Xfr Canal Floor Area	1400	ft2	Unl Pit Floor Area	210	ft2
S Unl Pool Sludge Volume	73	ft 3	Xfr Canal Sludge Volume	117	ft3	Unl Pit Sludge Volume	12	ft3
Total Floor Area	10,282	ft2						
Collective Average	1.44	in						
Estimated Sludge Volume	**1467**	**ft 3**						
	28.3	**L/ft3**						
	41,512	**liters**						

Table 1. Sludge Volume Estimate

5.2 Uranium Mass Estimate
The concentration of uranium, the sludge wet bulk density and observed sludge depth are used to calculate a nominal mass of fissile uranium in the sludge phase as shown in Table 2:
Fissile mass = Mean uranium concentration x Mean enrichment percentage x Sludge mass

Sludge mass = Sludge volume x Mean sludge density

Sludge volume = Basin floor area x Mean observed sludge depth

Basin Floor Area With Unload Pits and Pool				10,282	ft2
Estimated Sludge Volume				1,467	ft3
Sludge Wet Bulk Density				1.19	kg/L
Estimated Sludge Mass				4.93E+04	kg
Uranium Concentration (Average from Sample Data)				288	ug/g
			+/-	130	ug/g
Total Uranium Mass (Sludge mass x Concentration)				14	kg
				6	kg
U-235 Enrichment				49%	
			+/-	5%	
U-235 Mass in Sludge				**6.96**	**kg**
Uncertainty			+/-	**3.22**	**kg**

Table 2. Uranium Mass Estimate

The 6.96 ±3.22 kg U-235 mass is based on the average uranium concentration values and the corresponding sample standard deviation. In calculating the average uranium concentration, Sample ID 603013013A was excluded on the basis that its value is inconsistent with the other data. Due to its uranium enrichment being 10% of the other values, and its uranium concentration an order of magnitude higher, it is believed that a particle of unenriched uranium was entrained during sampling. The sample taken at this location (Northwest corner of the North Unloading Pit) was not consistent with the other samples because the sludge was not agitated using the Sample Isolation Device and the sample tube did not have a screened end. These concessions were made on the basis that there was insufficient room for the Sample Isolation Device at that location. The sample mass acquired at this location was only 1 gram of solids, therefore, a second, confirmatory analysis could not be performed. The Sample Isolation Device was not used in one location in the North Basin because the D-racks interfered with placement of the unit. Sampling in the South Basin was performed with sample tubes without screened ends due to plugging problems. These were presumed to be the result of sucking up flakes of aluminum oxide from aluminum rack screen corrosion.

The wet bulk density values for samples 603001013A and 603011013A were omitted from the average calculation on the basis that their values were below that for water. Excluding these values increases the average density, adding a degree of conservatism.

This approach was used to calculate the content of other radionuclides, shown in Appendix A2 and A3. The sludge mass was calculated from wet bulk density and apparent volume and the average concentration per mass was used to calculate a total mass. Values for nuclides in the water phase were calculated from average concentration and nominal water volume.

Collectively, the data from the silt/sludge phase and the water samples can be used to estimate the total value of radionuclide activity present in the basin.

6. Conclusion

While the concentrations of various nuclides identified through this characterization are considerably higher than those in the 1996 sample review (Demmer, 1996), the sludge depth and the density were shown to be substantially less than the assumed values. Although the estimated total mass of sludge is reduced, the total mass of fissile material remains substantially the same as that estimated in 1996.

References

1. PLN-977 Field Sampling Plan for the CPP-603 Basin Sludge
2 Basin Sludge Calculation for CPP-603 Fuel Basins-RLD-08-96, Letter, R.L. Demmer to Thornton Waite, August 20, 1996.
3. INTEC Analytical Laboratory Sample Log Number 02010141 Report for CPP-603 Sludge
4. INTEC Analytical Laboratory Sample Log Number 0201183 Report for CPP-603 Sediment
5. ` INTEC Analytical Laboratory Sample Log Number 0301063 Report for CPP-603 Sludge
6. INTEC Analytical Laboratory Sample Log Number 0305223 Report for CPP-603 Basin Supplemental Sample (Water)
7. INTEC Analytical Laboratory Sample Log Number 010605 (Water)
8. EDF-3535 CPP-603 Basins Fissile Material in Particulate Form Based on Cs-137 to U-235 Ratio

Appendix A1: Uranium and Bulk Density Sample Data:

Lab ID	Field ID	U-234 wt%	U-235 wt%	U-236 wt%	U-238 wt%	U tot ug/g	Wet Bulk Density (kg/L)
2BP27	603001013A	4.22E-01	5.08E+01	6.35E-01	4.82E+01	2.08E+02	*0.8324*
2BP28	603002013A	4.09E-01	5.25E+01	6.72E-01	4.64E+01	4.08E+02	1.25E+00
2BP29	603002023A	4.17E-01	5.28E+01	6.65E-01	4.61E+01	5.45E+02	1.08E+00
2BP30	603010013A	4.50E-01	5.38E+01	6.64E-01	4.51E+01	2.04E+02	1.01E+00
2BP31	603011013A	4.16E-01	5.14E+01	6.38E-01	4.76E+01	1.01E+02	*0.9285*
2BP32	603011023A	4.25E-01	5.06E+01	6.10E-01	4.84E+01	1.43E+02	1.07E+00
2BP33	603003013A	3.84E-01	4.83E+01	5.99E-01	5.07E+01	3.84E+02	1.22E+00
2BP34	603004013A	4.00E-01	5.04E+01	6.14E-01	4.86E+01	3.01E+02	1.23E+00
2BP35	603004023A	3.90E-01	5.00E+01	6.16E-01	4.90E+01	2.98E+02	1.70E+00
2BP36	603016013A	3.83E-01	4.54E+01	5.44E-01	5.37E+01	5.05E+02	1.18E+00
2BT14	603012013A	2.58E-01	2.92E+01	4.40E-01	7.01E+01	9.50E+01	1.23E+00
2BT16	603014013A	3.69E-01	4.18E+01	5.04E-01	5.73E+01	3.00E+02	1.07E+00
2BT17	603015013A	3.91E-01	4.87E+01	5.83E-01	5.03E+01	1.68E+02	1.09E+00
3AA24	603005013A	3.87E-01	5.09E+01	6.53E-01	4.80E+01	2.30E+02	1.07E+00
3AA25	603006013A	3.56E-01	4.62E+01	5.81E-01	5.29E+01	2.31E+02	1.03E+00
3AA26	603007013A	4.08E-01	5.16E+01	6.35E-01	4.74E+01	3.43E+02	1.08E+00
3AA27	603008013A	3.98E-01	5.10E+01	5.97E-01	4.80E+01	4.02E+02	1.47E+00
3AA28	603009013A	3.74E-01	4.99E+01	4.66E-01	4.92E+01	2.12E+02	1.23E+00
3AA29	603017013A	4.08E-01	5.25E+01	6.37E-01	4.65E+01	4.58E+02	1.09E+00
3AA30	603018013A	4.12E-01	5.25E+01	6.12E-01	4.64E+01	2.33E+02	1.27E+00
Average		3.93E-01	4.90E+01	5.98E-01	5.00E+01	2.88E+02	1.19E+00
Std Dev.		3.85E-02	5.46E+00	6.44E-02	5.55E+00	1.30E+02	1.72E-01
Italicized data excluded From Average							
2BT15	*603013013A*	*6.46E-02*	*6.42E+00*	*5.65E-02*	*9.35E+01*	*5.33E+03*	*1.10E+00*

Appendix A2: Alpha and Beta Emitters and Plutonium Isotopes

CPP-603 Transuranic and Gross Beta								
Lab ID	**Field ID**	**Alpha**	**Am-241**	**Pu238**	**Pu239**	**Total Pu**	**Beta**	
2BP27	603001013A	4.86E+04	6.70E+02	4.90E+03	3.07E+04	3.56E+04	1.05E+07	
2BP28	603002013A	4.31E+04	4.80E+02	4.25E+03	2.32E+04	2.75E+04	8.62E+06	
2BP29	603002023A	6.85E+04	7.40E+02	6.40E+03	3.79E+04	4.43E+04	1.13E+07	
2BP30	603010013A	1.18E+04	2.85E+02	1.60E+03	3.65E+03	5.25E+03	1.73E+07	
2BP31	603011013A	4.53E+03	1.08E+02	9.90E+02	1.95E+03	2.94E+03	1.52E+06	
2BP32	603011023A	8.98E+03	9.60E+01	6.00E+02	2.22E+03	2.82E+03	2.63E+06	
2BP33	603003013A	4.22E+04	4.50E+02	3.54E+03	2.36E+04	2.71E+04	7.82E+06	
2BP34	603004013A	4.67E+04	4.20E+02	4.97E+03	2.82E+04	3.32E+04	1.12E+07	
2BP35	603004023A	4.45E+04	4.30E+02	4.60E+03	3.05E+04	3.51E+04	1.10E+07	
2BP36	603016013A	4.49E+04	6.10E+02	3.90E+03	2.42E+04	2.81E+04	7.38E+06	
2BT14	603012013A	6.17E+03	3.51E+02	2.49E+03	2.14E+03	4.63E+03	1.34E+07	
2BT16	603014013A	1.20E+04	4.22E+02	9.50E+02	3.68E+03	4.63E+03	4.26E+06	
2BT17	603015013A	1.08E+04	2.68E+02	7.02E+02	3.69E+03	4.39E+03	1.24E+07	
3AA24	603005013A	2.53E+04	4.80E+02	9.10E+03	6.90E+04	7.81E+04	1.32E+07	
3AA25	603006013A	3.11E+04	4.63E+02	5.80E+03	4.25E+04	4.83E+04	1.29E+07	
3AA26	603007013A	7.45E+04	6.10E+02	1.25E+04	1.00E+05	1.13E+05	1.70E+07	
3AA27	603008013A	4.64E+04	5.60E+02	1.04E+04	8.70E+04	9.74E+04	1.24E+07	
3AA28	603009013A	5.29E+04	4.81E+02	9.20E+03	7.40E+04	8.32E+04	9.35E+06	
3AA29	603017013A	6.90E+04	6.80E+02	1.30E+04	1.17E+05	1.30E+05	1.59E+07	
3AA30	603018013A	1.00E+05	5.50E+02	1.21E+04	1.11E+05	1.23E+05	1.67E+07	
Average Value (pCi/g)		3.96E+04	4.58E+02	5.60E+03	4.08E+04	4.64E+04	1.08E+07	
Standard Deviation		2.61E+04	1.74E+02	4.12E+03	3.85E+04	4.26E+04	4.51E+06	
Sludge Mass (kg)		4.93E+04						
Sludge Inventory (pCi/g x kg x 1000 g/kg)								
Activity (pCi)		1.95E+12	2.25E+10	2.76E+11	2.01E+12	2.29E+12	5.34E+14	pCi
Activity (Ci)		1.95E+00	2.25E-02	2.76E-01	2.01E+00	2.29E+00	5.34E+02	Ci
Sample Excluded from Average								
2BT15	*603013013A*	*6.50E+05*	*1.02E+04*	*9.10E+03*	*5.28E+05*		*4.03E+07*	

ENGINEERING DESIGN FILE

CPP-603 Radionuclide Sample Results

Lab ID	Field ID	Ag-108m	Ag-110m	Ce-144	Co-58	Co-60	Cs-134	Cs-137	Eu-152	Eu-154	Eu-155	Mn-54	Nb-94	Nb-95	Ra-226	Ru-103	Ru-106	Sb-125	Sr	Zn-65	Zr-95
2BP27	603001013A	<5.63e3	<1.09e4	<2.82e3	1.63E+04	1.72E+06	<6.02e3	1.88E+06	3.90E+06	1.82E+06	1.70E+05	<7.45e3	<6.26e3	<7.16e3	<1.06e5	<6.53e3	<6.07e4	<1.7e4	2.78E+05	<3.07e4	1.31E+05
2BP28	603002013A	<3.10e3	<6.31e3	<1.55e4	7.91E+03	1.60E+06	<3.29e3	1.25E+06	2.28E+06	1.08E+06	1.08E+05	<4.16e3	<3.52e3	<3.97e3	<5.77e4	<3.59e3	<3.37e4	<9.49e3	4.16E+05	<1.64e4	8.48E+04
2BP29	603002023A	<4.13e3	<8.55e3	<2.04e4	1.71E+04	2.61E+06	<4.64e3	1.95E+06	3.90E+06	2.16E+06	1.84E+05	<5.67e3	<4.73e3	6.80E+03	<7.61e4	<4.82e3	<4.54e4	<1.25e4	3.54E+05	<2.63e4	1.41E+05
2BP30	603010013A	<5.67e3	<1.19e4	<3.1e4	3.71E+04	1.26E+06	<6.67e3	5.70E+05	8.85E+06	6.24E+06	3.86E+05	<8.14e3	<7.19e3	1.57E+04	<1.15e5	<6.89e3	<6.78e4	<1.72e4	2.71E+05	<3.58e4	3.98E+05
2BP31	603011013A	<1.65e3	<2.18e3	<7.21e3	<1.44e3	1.38E+05	<1.39e3	8.00E+05	2.65E+05	1.21E+05	1.06E+04	<1.43e3	<1.25e3	<1.39e3	<2.87e4	<1.75e3	<1.37e4	<5.01e3	1.11E+05	<5.81e3	<2.93e3
2BP32	603011023A	<2.39e3	<4.47e3	<1.18e4	<3.98e3	3.84E+05	<2.55e3	5.98E+05	9.89E+05	4.31E+05	3.19E+04	<3.02e3	<2.59e3	<2.91e3	<4.54e4	<2.73e3	<2.51e4	<7.27e3	1.13E+05	<1.25e4	3.17E+04
2BP33	603003013A	<3.64e3	<6.67e3	<1.89e4	1.49E+04	3.35E+05	<3.9e3	1.26E+06	3.74E+06	1.98E+06	1.50E+05	<4.59e3	<4.05e3	9.31E+03	<7.06e4	<4.23e3	<3.96e4	<1.09e4	1.65E+05	<2.15e4	1.36E+05
2BP34	603004013A	<4.16e3	<6.81e3	<2.03e4	1.50E+04	3.38E+05	<4.09e3	3.03E+06	4.28E+06	2.45E+06	1.79E+05	<4.66e3	<4.11e3	9.10E+03	<7.78e4	<4.69e3	<4.13e4	<1.26e4	5.37E+05	<2.18e4	1.58E+05
2BP35	603004023A	<4.32e3	<6.69e3	<2.1e4	1.53E+04	3.22E+05	<4.27e3	3.11E+06	4.09E+06	2.35E+06	1.79E+05	<4.76e3	<4.26e3	6.30E+03	<8.05e4	<4.89e3	<4.26e4	<1.3e4	5.04E+05	<2.15e3	1.51E+05
2BP36	603016013A	<2.68e3	<5.06e3	<1.42e4	1.17E+04	2.86E+05	<2.96e3	7.62E+05	3.16E+06	1.50E+06	1.26E+05	<3.51e3	<3.1e3	9.39E+03	<5.01e4	<3.18e3	<2.99e4	<8.15e3	4.15E+05	<1.56e4	1.24E+05
2BT14	603012013A	<1.5e3	<3.73e3	<4.99e3	<2.23e3	7.22E+06	<1.52e3	4.65E+06	9.09E+05	3.41E+05	1.57E+04	<2.35e3	<1.72e3	<1.99e3	<1.99e4	<1.55e3	<1.56e4	<4.5e3	5.88E+05	1.50E+05	2.29E+04
2BT16	603014013A	<1.01e3	<2.55e3	<3.82e3	3.87E+03	1.67E+06	<1.09e3	9.05E+05	8.57E+05	3.46E+05	2.03E+04	<1.63e3	<1.24e3	<1.43e3	<1.49e4	<1.07e3	<1.12e4	<3.05e3	3.40E+05	<4.17e3	2.46E+04
2BT17	603015013A	3.35E+03	<1.47e3	<5.89e3	3.46E+03	2.05E+06	<8.86e3	6.76E+06	6.61E+05	3.67E+05	2.92E+04	<9.65e2	<7.58e2	<8.67e2	<2.25e4	<1.14e3	<8..93e3	7.90E+03	1.09E+06	<3.3e3	2.31E+04
3AA24	603005013A	<4.75e3	<9.74e3	<2.67e4	4.53E+04	6.47E+05	<5.54e3	6.71E+05	1.05E+07	5.05E+06	3.30E+05	<6.84e3	<6.02e3	<6.81e3	<9.87e4	<5.75e3	<5.67e4	<1.44e4	5.68E+05	<3.01e4	3.51E+05
3AA25	603006013A	<4.67e3	<9.39e3	<2.58e4	3.52E+04	7.45E+05	<5.38e3	1.03E+06	8.91E+06	4.26E+06	<2.23e4	<6.53e3	<5.75e3	2.08E+04	<9.58e4	<5.64e3	<5.44e4	<1.41e4	6.72E+05	<2.93e4	2.91E+05
3AA26	603007013A	<6.85e3	<1.36e4	<3.79e4	5.40E+04	4.60E+05	<7.82e3	1.29E+06	1.24E+07	5.82E+06	4.22E+05	<9.59e3	<8.48e3	1.45E+04	<1.34e5	<8.22e3	<7.97e4	<2.06e4	6.60E+05	<4.23e4	3.70E+05
3AA27	603008013A	<6.6e3	<1.28e4	<3.65e4	4.10E+04	3.03E+05	<7.38e3	9.40E+05	9.41E+06	4.36E+06	3.01E+05	<8.99e3	<7.95e3	2.26E+04	<1.35e5	<7.8e3	<7.62e4	<1.97e4	2.92E+05	<4.13e4	3.03E+05
3AA28	603009013A	<4.56e3	<8.95e3	<2.53e4	<6.69e3	1.64E+05	<5.18e3	7.12E+05	6.62E+06	2.97E+06	1.89E+05	<6.28e3	<5.56e3	1.47E+04	<9.34e4	<5.44e3	<5.24e4	<1.37e4	3.41E+05	<2.89e4	2.10E+05
3AA29	603017013A	<5.28e3	<1.04e4	<2.92e4	5.26E+04	3.60E+05	<6.05e3	1.39E+06	1.25E+07	6.08E+06	4.25E+05	<7.28e3	<6.46e3	2.62E+04	<1.08e5	<6.36e3	<6.14e4	<1.59e4	4.62E+05	<3.412e4	4.17E+05
3AA30	603018013A	<5.87e3	<1.17e4	<3.29e4	5.35E+04	3.71E+05	<6.77e3	1.52E+06	1.29E+07	6.34E+06	<2.84e4	<8.16e3	<7.24e3	2.85E+04	<1.21e5	<7.06e3	<6.87e4	<1.79e4	4.63E+04	<3.67e4	4.30E+05
Average Value (pCi/g)		<3.35e3	<1.36e4	<3.79e4	2.65E+04	1.15E+06	<8.86e3	1.75E+06	5.56E+06	2.80E+06	1.81E+05	<9.59e3	<8.48e3	1.53E+04	<1.35e5	<8.22e3	<2.06e4	7.90E+03	4.11E+05	1.50E+05	2.00E+05
Standard Deviation					1.79E+04	1.56E+06		1.53E+06	4.23E+06	2.14E+06	1.36E+05			7.30E+03				0.00E+00	2.36E+05	0.00E+00	1.39E+05
Sludge Mass (kg)		4.93E+04																			
Activity (pCi)		*1.65E+11*	*6.70E+11*	*1.87E+12*	1.31E+12	5.66E+13	*4.36E+11*	8.64E+13	2.74E+14	1.38E+14	8.91E+12	*4.72E+11*	*4.18E+11*	7.55E+11	*6.65E+12*	*4.05E+11*	*1.01E+12*	3.89E+11	2.03E+13	7.39E+12	9.85E+12
Activity (Ci)		*1.65E-01*	*6.70E-01*	*1.87E+00*	1.31E+00	5.66E+01	*4.36E-01*	8.64E+01	2.74E+02	1.38E+02	8.91E+00	*4.72E-01*	*4.18E-01*	7.55E-01	*6.65E+00*	*4.05E-01*	*1.01E+00*	3.89E-01	2.03E+01	7.39E+00	9.85E+00
Activity(pCi) = pCi/g x mass kg x 1000 g/kg				Activity(Ci) = Activity(pCi) x 1 E -12				Italicized values calculated from largest "less than" value.													
Excluded from average																					
2BT15	603013013A	<2.37e3	<1.93e3	<1.07e4	2.98E+03	3.42E+06	<1.49e3	2.89E+07	5.98E+05	3.19E+05	3.50E+04	<1.26e3	4.27E+03	<1.13e3	<4.16e4	<2.14e3	<1.49e4	<7.09e3	2.65E+06	<3.96e3	1.98E+04

Appendix A3: Gamma Emitters and Strontium

Appendix B Additional Isotopes Analyzed from Liquid Phase:
Due to analytical difficulty associated with recovery of certain isotopes from the fusion method used for the solids, H-3, C-14, Tc-99, and I-129 values were taken from analysis of four samples of basin water. Since the basins are connected, it may be assumed that the concentration of dissolved constituents is relatively uniform. Samples were taken from the South Basin, and the Transfer Canal. Four 250-ml samples were taken. The results of the liquid phase analyses are as follows:

Field Sample ID								
	Tc-99 (pCi/L)	**Uncertainty**	**H-3 (pCi/L)**	**Uncertainty**	**I-129 (pCi/L)**	**Uncertainty**	**C-14 (pCi/L)**	**Uncertainty**
CPP-603 Basin SUP1	1.65E+02	5.10E+00	1.65E+04	1.40E+02	1.00E-01	2.30E+00	9.00E+01	4.10E+01
CPP-603 Basin SUP2	1.39E+02	5.00E+00	1.62E+04	1.40E+02	2.40E+00	2.40E+00	*-18*	3.90E+01
CPP-603 Basin SUP3	1.20E+02	5.00E+00	1.63E+04	1.40E+02	1.50E+00	2.10E+00	3.90E+01	4.00E+01
CPP-603 Basin SUP4	5.50E+00	4.80E+00	1.55E+04	1.40E+02	*-3*	2.60E+00	3.20E+01	3.90E+01
Average pCi/L	1.07E+02	4.98E+00	1.61E+04	1.40E+02	1.33E+00	2.35E+00	5.37E+01	3.98E+01
Standard Dev. pCi/L	7.04E+01		4.49E+02		1.16E+00		3.17E+01	
Basin Volume	5.83E+06	Liters						
Total pCi	6.26E+08		9.39E+10		7.77E+06		3.13E+08	
Total Ci	6.26E-04		9.39E-02		7.77E-06		3.13E-04	

Calculation of the total curies is based on total basin volume x concentration per liter. The assumption for iodine, carbon and technetium is that these species are in solution in the water, and would be precipitated as solids in the event that the basin water were progressively evaporated. Typical operational sampling of the basin water for radionuclides includes primarily gamma emitters. The isotopes most commonly detected are cobalt-60, cesium-137, europium-152 and europium-154. The following are gamma emitter and strontium data for samples taken during 2001.

Isotope	Zr95	Co60	Cs134	Cs137	Eu152	Eu154	Eu155	Sb125	Total Sr
Date	uCi/mL	uCi/mL	ug/mL	uCi/mL	uCi/mL	uCi/mL	uCi/mL	uCi/mL	uCi/mL
6-Jun-01	1.51E-07	5.29E-08		9.52E-05	4.35E-06	1.85E-06			1.18E-04
3-Apr-01		3.69E-08		9.20E-05	1.69E-06	7.42E-07			1.00E-04
6-Mar-01		9.98E-09		9.21E-05	3.17E-07	1.25E-07			1.13E-04
6-Feb-01		8.80E-09		1.11E-04	3.36E-07	1.51E-07			1.00E-04
3-Jan-01		1.21E-08		9.89E-05	3.67E-07	1.62E-07			1.28E-04
2001 average		2.41E-08		9.78E-05	1.41E-06	6.06E-07			1.12E-04
Basin Total (uCi)		1.41E+02		5.70E+05	8.23E+03	3.53E+03			6.51E+05
Basin Total (Ci)		1.41E-04		5.70E-01	8.23E-03	3.53E-03			6.51E-01

Table 3. Sample locations and analyses for CPP-603 basin sludge sampling effort.

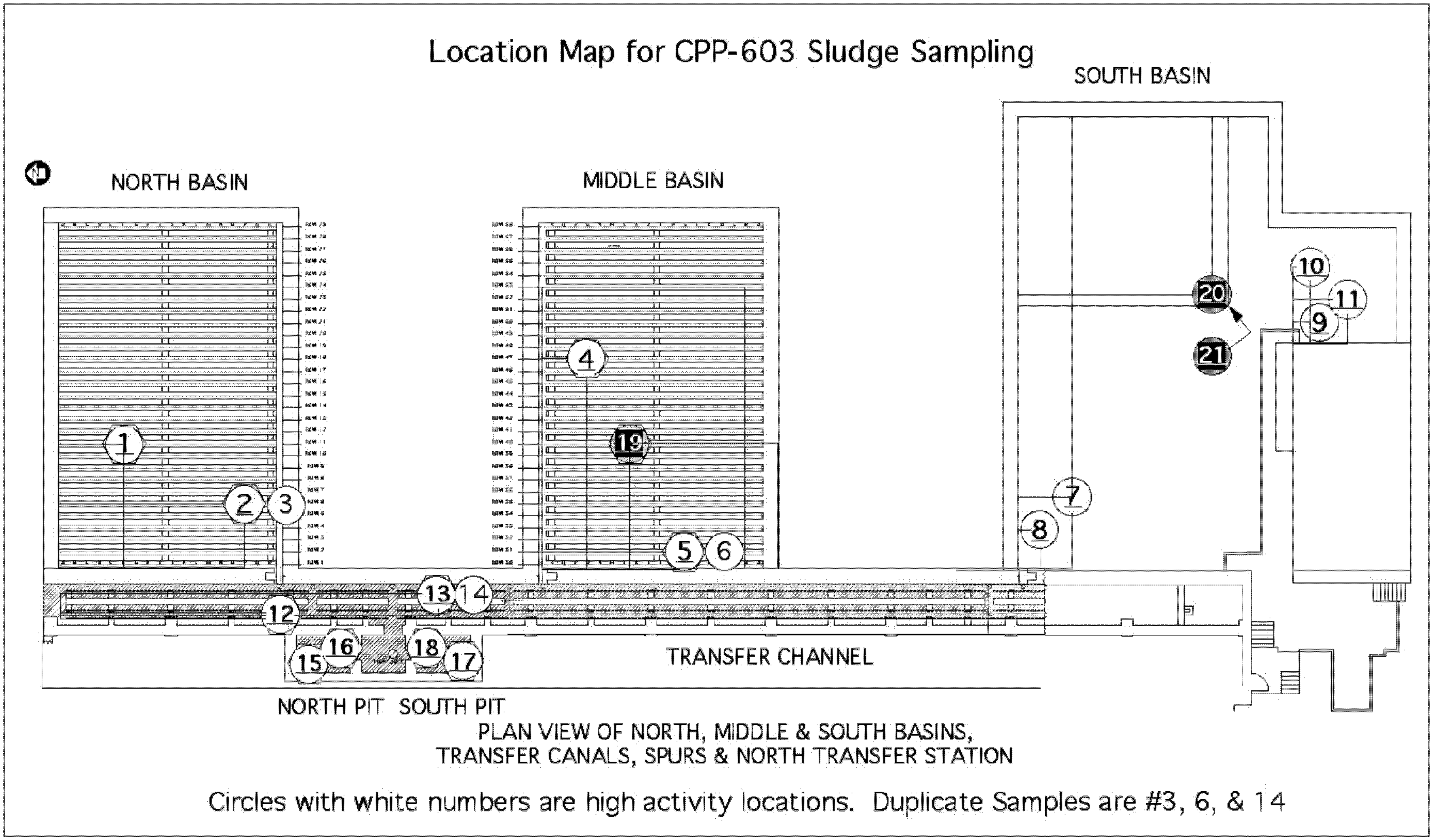
Sample No.	Basin	Grid ID	North	West
1	North	932	12	23
2	North	514	34	12
3	North (duplicate)	TBD	TBD	TBD
4	Middle	1568	8	39
5	Middle	106	26	2
6	Middle (duplicate)	TBD	TBD	TBD
7	South	270	10	13
8	South	144	4	7
9	South Cutting Area	85	5	4
10	South Cutting Area	283	3	14
11	South Cutting Area	170	10	8
12	Transfer Channel	280	40	3
13	Transfer Channel	549	69	6
14	Transfer Channel (duplicate)	TBD	TBD	TBD
15	Transfer Pit (North)	6	1	6
16	Transfer Pit (North)	205	5	8
17	Transfer Pit (South)	141	16	5
18	Transfer Pit (South)	189	14	7
19	Hot Sample 1 – Middle Basin	TBD	TBD	TBD
20	Hot Sample 2 – South Basin	TBD	TBD	TBD
21	Hot Sample 3 – South Basin	TBD	TBD	TBD

TBD = to be determined

Appendix C1. Basin Sampling Plan (PLN-977) TBD values are shown on Appendix C2. North and West distances are in feet. Grid IDs are independent of Row and Position numbers.

Appendix C2. Locations Sampled per PLN-977

No.	Basin	Grid ID	North	West
1	North	932	12	23
2	North	514	34	12
3	North (duplicate)	514	34	12
4	Middle	1568	8	39
5	Middle	106	26	2
6	Middle (duplicate)	106	26	2
7	South	270	10	13
8	South	144	4	7
9	South Cutting Area	85	5	4
10	South Cutting Area	28	3	14
11	South Cutting Area	170	10	8
12	Transfer Channel	280	40	3
13	Transfer Channel	549	69	6
14	Transfer Channel (duplicate)	549	69	6
15	Transfer Pit (North)	6	1	6
16	Transfer Pit (North)	205	5	8
17	Transfer Pit (South)	141	16	5
18	Transfer Pit (South)	189	14	7
19	Hot Sample 1 — Middle Basin	NA	13	27
20	Hot Sample 2 — South Basin	NA	33	36
21	Hot Sample 3 — South Basin	NA	35	38



Appendix C3 Map of Sampling Locations

5. SAMPLE HANDLING AND ANALYSIS

5.1 Analytical Methods

Table 4 lists the methods that will be used to determine COC concentrations in the CPP-603 basin sludge samples. The analyses, listed in Table 4, provide for complete characterization of the identified COCs, in addition to providing sufficient coverage of the radionuclide inventory such that the entire radionuclide inventory can be derived from the physical sample results and scanning data. Radionuclide determinations will be made per the requirements in the *INEEL Sample Management Office Statement of Work for Radionuclide Analysis* (ER-SOW-163). The detection limits specified for the radioanalytical determinations appear in Table 4-1a of ER-SOW-163.

Table 4. Analytical methods for CPP-603 basin sludge sample analyses.

Radionuclide Analysis	Method[a]
Am-241	Americium-241 by alpha spectrometry as per ER-SOW-163
Co-58, Co-60 Cs-134, Cs-137 Eu-152, Eu-154, Eu-155 Sb-125 Tl-208	Gamma Spectroscopy as per ER-SOW-163
Pu-238, Pu-239/240	Isotopic Plutonium by alpha spectrometry as per ER-SOW-163
Pu-241	Plutonium-241 as per ER-SOW-163
Sr-90	Total Strontium[b] (Sr-89/90) as per ER-SOW-163
U-233, U-234, U-235, U-236, U-238	Isotopic Uranium by ICP[c] Mass Spectroscopy as per ER-SOW-156[d]
Gross alpha/beta	Gross alpha/beta as per ER-SOW-163

a. ER-SOW-163 is the radioanalytical master task agreement that specifies the requirements the laboratory must meet. It does not specify actual analytical methodology, but is a performance-based document against which the laboratory is compared.

b. Process knowledge (see Table 1) indicates the likelihood of Sr-89 being present is very low and, thereby, total strontium is expected to give an indication of only Sr-90 activity. If in the event any Sr-89 is present, the activity would be calculated using Sr-90 efficiency which would provide a "worst case scenario" activity.

c. Inductively coupled plasma.

d. *INEEL Sample Management Office Statement of Work for Inorganic and Miscellaneous Classical Analyses* (ER-SOW-156).

5.2 Sample Handling

Sampling personnel will collect samples in appropriate sample containers. The radiological control technician must perform radiation surveys and apply radiological labels to the sample containers, as appropriate. It is important to collect sufficient amounts of sample to allow for the requested analyses to be performed. Insufficient sample amounts could impact detection limits achieved at the laboratory and, therefore, the ability to make decisions using the data. The appropriate containers and preservatives are specified in Table 5.

Appendix D. Sample Analytical Method (Sludge) Excerpt from PLN-977 (COC – Contaminant of Concern)